Real Estate Diversification Benefits

*Dirk P.M. De Wit**

Abstract. **Diversification benefits are shown to vary inversely with the correlation between asset returns. The present study estimates average correlation coefficients between real-estate returns from property-specific data of an internationally diversified real estate fund in the Netherlands. It is found that diversification benefits within the United States are much larger than on the European Continent. The low correlation found between U.S. real estate returns implies that portfolios of small numbers of U.S. properties would require large return premia. Also, the study helps to explain why financial intermediaries exist in the real estate industry and when investors should consider employing them.**

Introduction

Diversification is crucial to investors because asset returns do not move in perfect unison. Diversification benefits vary inversely with the correlation between asset returns. With respect to real estate assets, however, little empirical evidence exists due to the lack of property-specific data. The present study estimates average correlation coefficients between real estate returns from detailed data in the annual reports of Rodamco N.V., an internationally diversified real estate fund listed on the Amsterdam Stock Exchange.

It is shown that the average correlation coefficient between returns determines several aspects of diversification benefits, that is, the level of maximum risk reduction, the rate at which risk is reduced, and the trade-off between risk and return when portfolios cannot be perfectly diversified. The latter aspect is important for real estate portfolios because property ownership is often indivisible, so that diversification cannot be taken to the limit.

The present study has major implications for the existence of financial intermediaries, such as Real Estate Investment Trusts (REITs) and Commingled Real Estate Funds (CREFs). If real estate portfolios cannot be perfectly diversified, so that investors forgo some of the potential gains from diversification, financial intermediaries may exist as a method for providing lower levels of risk. The present study estimates the excess risk from imperfect diversification in order to assess the costs that investors should be prepared to incur for sharing risks.

The next section of this work provides a discussion of the literature and methodology regarding the measurement of diversification benefits. This is followed, in the third section, by a detailed look at the data. The fourth section delivers the empirical results, and compares these to some earlier findings. The last section concludes and summarizes the study.

*School of Banking and Finance, The University of New South Wales, Sydney 2052 Australia and Stichting De Quintessents, Amsterdam, The Netherlands.
Date Revised—May 1996; Accepted—October 1996.

Literature and Methodology

Evans and Archer (1968) and Latané and Young (1969) provided the first empirical estimates of the rate at which risk is reduced with increasing numbers of stocks in a portfolio. They did so by fitting a regression model to the standard deviations of simulated portfolio returns. However, Whitmore (1970) showed that, instead of the standard deviations, the models should have used the variances of the simulated portfolio returns. Evans (1975) found that the reduction of the standard deviation of returns is a function of both the number of stocks in a portfolio and the average correlation coefficient between returns.

The incidence of diversification benefits, or the reduction of risk, is kept to a maximum by the nature of the market in which the assets trade. This maximum may thus differ between, for instance, stock markets and real estate markets. The average correlation coefficient between returns is a comprehensive measure of diversification benefits that reflects the level of maximum risk reduction, and also implies the reduction rate of risk, whether risk is defined as the variance or standard deviation of returns.

Furthermore, as will be shown below, the average correlation coefficient between returns is an important determinant of the required excess return from imperfect diversification. Due to the indivisibility of property ownership, diversification cannot be taken to the limit. Real estate portfolios will therefore often contain relatively large quantities of diversifiable risk, for which the investor should require to be compensated: the average correlation coefficient suggests how much.

Similar to Evans (1975) and Elton and Gruber (1977), it is assumed that the means and (co-)variances of returns are identically distributed. With no information about these return characteristics one could assume that they do not differ across assets. Consequently, it would be optimal to buy equal amounts of each investment (see Samuelson, 1967). If the means and (co-)variances of returns can be forecast, however, buying unequal amounts of each investment may lead to further reduction of risk. Equal investment may thus be seen as an upper limit on the risk the investor faces. An operational measure of this bound is developed below.

Level of Maximum Risk Reduction

For an equally weighted portfolio, the weights are inversely related to the number of assets in the portfolio, which implies that the variance of the returns on such a portfolio can be written as follows (see, e.g., Elton and Gruber, 1991):

$$\sigma_n^2 = \sum_{i=1}^{n} \frac{1}{n^2}\sigma_i^2 + \sum_{i=1}^{n}\sum_{\substack{j=1 \\ j\neq 1}}^{n} \frac{1}{n^2}\sigma_{ij} , \tag{1}$$

where σ_n^2 is the variance of returns of a portfolio containing n assets, σ_i^2 is the variance of returns of assets i, and σ_{ij} is the covariance between returns on assets i and j. Equation (1) can be simplified by substituting the averages of σ_i^2 and σ_{ij}, that is $\bar{\sigma}_i^2$ and $\bar{\sigma}_{ij}$, respectively:

$$\sigma_n^2 = \frac{1}{n}\bar{\sigma}_i^2 + \frac{n-1}{n}\bar{\sigma}_{ij} . \tag{2}$$

Further, one may estimate the average covariance between returns from the variance of the returns of an equally weighted portfolio of all assets in the population, where the portfolio has to be rebalanced at the end of each period to maintain equal weights:

$$\bar{\sigma}_{ij} = \frac{N}{N-1}\sigma_N^2 - \frac{1}{N-1}\bar{\sigma}_i^2 , \tag{3}$$

where σ_N^2 is the variance of the returns of an equally weighted reallocation index-portfolio of all assets in the population, and N is the total number of assets in the population.

For the variance of the returns of a portfolio of n ($n \leq N$) assets, substituting the last expression into equation (2) yields:

$$\sigma_n^2 = \left[\frac{1}{n}\sigma_i^2\right]\frac{N-n}{N-1} + \left[\frac{n-1}{n}\sigma_N^2\right]\frac{N}{N-1} . \tag{4}$$

Note that $\sigma_n^2 = \bar{\sigma}_i^2$ if $n=1$, and reduces to σ_n^2 if $n=N$; the various adjustment factors correct for finite sampling without replacement.

A measure of the level of maximum diversification benefits is obtained by taking the ratio of the average covariance to the average variance of returns. From the definition of the correlation coefficient ($\rho_{ij} = \sigma_{ij} \,/\, (\sigma_i \sigma_j)$), and the assumption that the variances are identically distributed, it follows that this ratio is equivalent to $\bar{\rho}_{ij}$, the average correlation coefficient between returns on assets i and j:

$$\bar{\rho}_{ij} = \frac{\bar{\sigma}_{ij}}{\bar{\sigma}_i^2} . \tag{5}$$

In order to arrive at an empirically more convenient measure of diversification benefits, the right-hand side of equation (3) can be substituted for $\bar{\sigma}_{ij}$ in (5) to yield the following expression for the average correlation coefficient:

$$\bar{\rho}_{ij} = \left[\frac{\sigma_N^2}{\bar{\sigma}_i^2}\right]\frac{N}{N-1} - \frac{1}{N-1} . \tag{6}$$

Equation (6) provides an operational measure of diversification benefits. Note that, while the maximum value of $\bar{\rho}_{ij}$ is $+1$ for $\sigma_N^2 = \bar{\sigma}_i^2$, the minimum value of $\bar{\rho}_{ij}$ is zero in the limit. Also, our measure indicates that portfolio risk can be reduced to $(1-\bar{\rho}_{ij})$ of total risk.

Rate of Risk Reduction

Following Evans (1975), the rate at which the variance of returns is reduced with increasing numbers of assets in a portfolio can be determined by forming the ratio:

$$\delta_v = \frac{\sigma_n^2 - \bar{\sigma}_{ij}}{\bar{\sigma}_i^2 - \bar{\sigma}_{ij}} . \tag{7}$$

This ratio measures the size of the remaining diversifiable risk in a portfolio relative to total diversifiable risk. Substituting equation (2) into equation (7), and rearranging terms, yields the rate at which the (diversifiable component of the) variance of returns is reduced, that is:

$$\delta_v = \frac{1}{n}. \tag{8}$$

The reduction rate of the standard deviation can be determined similarly, but appears to be a function of both the number of assets in the portfolio and the average correlation coefficient between returns. Assuming again that variances are identically distributed, so that $\bar{\sigma}_{ij} = \bar{\rho}_{ij}\,\bar{\sigma}_i^2$:

$$\delta_s = \frac{\sigma_n - \sqrt{\bar{\sigma}_{ij}}}{\bar{\sigma}_i - \sqrt{\bar{\sigma}_{ij}}} = \frac{\sqrt{\frac{1}{n} + \bar{\rho}_{ij}\frac{n-1}{n}} - \sqrt{\bar{\rho}_{ij}}}{1 - \sqrt{\bar{\rho}_{ij}}}, \tag{9}$$

where δ_s is the rate at which the standard deviation of returns is reduced with increasing numbers of assets in a portfolio. Evans (1975) shows that δ_s approaches $1/n$ if the average correlation coefficient approaches $+1$. However, for $\bar{\rho}_{ij}$ less than $+1$ (equal to zero), evaluating equation (9) yields δ_s larger than $1/n$ (equal to $1/\sqrt{n}$). Thus, when risk is defined as the standard deviation of returns, the level of maximum risk reduction also commands the rate at which (the diversifiable component of) risk is reduced.

Required Excess Return from Imperfect Diversification

Thus far, the analysis suggests that diversification should be taken to the limit in order to minimize risk. While some authors have argued that most of the diversifiable risk is reduced by holding ten or so assets, Elton and Gruber (1977) have drawn attention to the size of the remaining diversifiable risk relative to non-diversifiable risk by forming the ratio $(\sigma_n^2 - \bar{\sigma}_{ij}) / \bar{\sigma}_{ij}$. For $n=10$, for instance, Elton and Gruber find that the remaining diversifiable risk is 56% of the minimum. Moreover, it can be shown that their ratio is a function of the empirically determined level of maximum risk reduction, that is the average correlation coefficient.[1] This implies that diversification should be taken to the limit.

Statman (1987), while using the data provided by Elton and Gruber (1977), considers the trade-off between risk and return of diversified portfolios when perfect diversification through an index fund is costly vis-à-vis imperfect diversification. Statman shows that the index fund would dominate portfolios of as much as thirty stocks, since the low risk of the former more than compensates for its costs, being estimated at 0.5% per annum. If the index fund is less costly the riskiness of the imperfectly diversified portfolio should be further reduced by including more than thirty stocks.

However, real estate portfolios cannot be perfectly diversified due to the indivisibility of property ownership. The trade-off between risk and return is, here, necessitated by the amount of the remaining diversifiable risk relative to total portfolio risk. This 'excess risk' may be determined by forming the ratio:

$$\tau_v = \frac{\sigma_n^2 - \bar{\sigma}_{ij}}{\sigma_n^2}. \tag{10}$$

where τ_v is the excess variance from imperfect diversification. Note that under the stated assumptions $\bar{\sigma}_{ij}=\bar{\rho}_{ij}\,\bar{\sigma}_i^2$. By substituting equation (2) into equation (10), and rearranging terms, τ_v is shown to be a function of the number of assets in a portfolio and the average correlation coefficient:

$$\tau_v = 1 - \frac{\bar{\rho}_{ij}}{\frac{1}{n} + \bar{\rho}_{ij}\frac{n-1}{n}}. \tag{11}$$

Similarly, the excess standard deviation from imperfect diversification can be written as follows:

$$\tau_s = \frac{\sigma_n - \sqrt{\bar{\sigma}_{ij}}}{\sigma_n} = 1 - \sqrt{\frac{\bar{\rho}_{ij}}{\frac{1}{n} + \bar{\rho}_{ij}\frac{n-1}{n}}}. \tag{12}$$

The level of maximum risk reduction thus also commands the excess risk from imperfect diversification, whether risk is defined as the variance or standard deviation of returns.

In order to translate the measure of excess risk into a measure of the required excess return from imperfect diversification, a model of equilibrium prices is needed. Using the Sharpe-Lintner version of the capital asset-pricing model, Mao (1970, p. 1112) proposes the following measure of the relative gain from diversification:

$$\alpha = \frac{\Theta_n - \Theta_i}{\Theta_\infty - \Theta_i}, \tag{13}$$

where α measures the actual gain as a proportion of the maximum possible gain from diversification, Θ is the return in excess of the risk-free rate of interest divided by the standard deviation of returns, and the subscripts denote portfolio size. Mao shows that α is a function of both the number of assets in a portfolio and the average correlation coefficient between returns; if diversification is taken to the limit the value of α approaches 1.

In real estate markets, where property ownership is often indivisible, α will not arrive at its optimal value because the number of assets in a portfolio cannot be increased infinitely. If wealth constraints limit the number of properties in a portfolio, the standard deviation of the returns of a randomly selected portfolio is no longer subject to minimization. The α measure will then be optimized only if the portfolio return compensates for the excess risk from imperfect diversification. Equation (13) implies that $\alpha=1$ if $\Theta_n=\Theta_\infty$. Thus, α is optimized by solving the π in:

$$\frac{\mu - r_f + \pi}{\sigma_n} = \frac{\mu - r_f}{\sqrt{\bar{\sigma}_{ij}}}, \tag{14}$$

where μ is the mean return, r_f is the risk-free rate of interest, and π is the required excess return from imperfect diversification. Note that equation (12) can be rewritten as

$\sigma_n=\sqrt{\bar{\sigma}_{ij}}$ / $(1-\tau_s)$; substituting this last expression into equation (14). and rearranging terms, yields:

$$\pi=(\mu-r_f)\frac{\tau_s}{1-\tau_s}. \tag{15}$$

From equation (15), it appears that the required excess return from imperfect diversification is a function of the return in excess of the risk-free rate of interest, and through τ_s, the number of assets in a portfolio, and the average correlation coefficient between returns.

The $\bar{\rho}_{ij}$ measure is thus shown to determine the level of maximum risk reduction, the rate at which risk is reduced, and the required excess return from imperfect diversification. The remainder of this study is therefore concerned with obtaining empirical estimates of this measure to lighten the various aspects of real estate diversification benefits.

Data Description

Data is used from the annual reports of Rodamco N.V., the largest real estate fund listed on the Amsterdam Stock Exchange with a market capitalization of \$US5.5 billion at 28 February 1990, the end of its 1989/1990 book year. The major real estate funds in the Netherlands, including Rodamco, have obtained the legal status of open-end mutual funds, which enables the funds' management to purchase or sell shares at their discretion. They thus resemble U.S. open-end commingled real estate funds (CREFs), except that the latter do not publicly trade. From its inception in March 1979 through February 1990, the open-end status of Rodamco facilitated a phenomenal 30% annual growth rate of the fund's number of shares outstanding. As a result, Rodamco became the fourth largest stock listed on the Amsterdam Stock Exchange by 1989.

Sample Characteristics

The annual reports of Rodamco during the period 1979–90 provide detailed data with respect to 183 individual properties. From 1987, data are given only for properties worth at least NLG10 million (\$US1.00=NLG1.91 at 28 February 1990). In order to avoid inconsistencies in the set of data, returns have been calculated only for those properties with a market value greater than NLG10 million. Hence, 56 small properties are excluded from the set of data. Furthermore, 24 large properties have been in the portfolio for just one year and, therefore, do not provide sufficient data to make their inclusion in the set of data worthwhile. Thus, the data set pertains to 103 individual properties, which represent a market value of more than NLG10 million and have been mentioned in at least two annual reports during the sample period.

Further insight into the sample characteristics is provided by Exhibit 1, which gives the means, medians and standard deviations of property values by geographic region for 1989. Hence, the market value of properties sold before the end of 1989 is approximated by multiplying the last available value by the index returns of the relevant country in subsequent years, thus assuming an average value growth of sold properties.

Exhibit 1
Breakdown of Sample by Country, Region, and Property Size

Country or Region	Number of Properties	Mean Value ($1 m.)	Median Value ($1 m.)	Std Dev.
United States	29	98.9	79.3	60.8
East	11	112.0	110.7	74.4
Midwest	6	113.8	99.8	50.9
South	7	77.6	79.0	40.4
West	5	82.1	63.4	48.3
European Continent	33	29.4	14.3	60.7
Germany	10	20.2	15.6	11.8
Netherlands	14	39.2	10.2	90.8
Belgium	5	15.1	10.6	8.1
France	4	36.2	34.1	16.3
United Kingdom	41	24.2	12.6	25.1
Total Sample	103	46.9	19.5	59.5

Note: The market value of properties sold before the end of 1989 is approximated by multiplying the last available value with the index returns of the relevant country in subsequent years. Also, $US1.00=NLG 1.91.

Under these conditions, the mean value of the sample properties is $46.9 million at the end of 1989. However, there are some very large properties in the sample, as evidenced by the substantially lower median value of $19.5 million. These large properties are predominantly located in the U.S., where 29 properties have an average value of $98.9 million. The European Continent (E.C.) and U.K. property size is generally much smaller than the U.S. average. The single largest property, however, is a super-regional mall of over 800,000 sq. ft. located in the Netherlands, which was partially owned by Rodamco for some years during the sample period; the 1989 value of the (sold) property was approximated at $365 million.

The total market value of all properties in the sample is $4.8 billion by the end of 1989, while the U.S. properties, which are often partially owned by Rodamco, represent a total market value of $2.9 billion. In comparison, the Russell-NCREIF (RN) Index represented $17.4 billion worth of U.S. real estate at year-end 1989. However, the average value of the Rodamco U.S. sample properties is considerably larger than the 1989 average value of the RN Index properties, which is $13.6 million. Moreover, the sample is more concentrated in the East than the RN Index (43% and 25% of total value, respectively), and less concentrated in the West (14% versus 42%).

Exhibit 2 provides some insight into another important aspect of the sample. A large number of properties are offices (63), which thereby outnumber retail, warehouse and apartment type properties. However, most retail properties are relatively large with a floorspace of over 200,000 sq. ft located in the U.S. In terms of value, the sample is, therefore, fairly balanced between office and retail, while it is relatively underweighted in warehouses and apartments. The near absence of industrial and residential properties in the U.S. sample may be contrasted with their weighting in the RN Index by year-end

Exhibit 2
Number of Sample Properties by Country and Property Type

	Office	Retail	Warehouse	Apartment	Total
United States	9	19	1	0	29
European Continent	19	8	5	1	33
United Kingdom	35	0	6	0	41
Total Sample	63	27	12	1	103

Note: Some office buildings include retail space, namely three U.S. offices, three E.C. offices and eleven U.K. offices, while two retail properties in the E.C. include apartments and office space.

1989, namely 35% and 7% of the total number of properties, respectively. The unique characteristics of the sample may affect the results of the ensuing analysis.

Calculation of Returns

The fund's annual reports specify the outcomes of independent outside appraisals by country, and, also, provide detailed property-specific data, including gross rental income per property. This information allows for the calculation of (time-varying) capitalization (or discount) rates for the properties in a certain country by relating the sum of gross rental income for those properties to the relevant appraisal value. Then, this discount rate is used to capitalize gross rental income per property, which yields an 'imputed value'. Note that, by definition, the sum of the imputed values for properties in a certain country must equal the reported appraisal value. This procedure can be summarized as follows:

$$V_{ik,t} = \frac{I_{ik,t}}{d_{k,t}}, \tag{16}$$

$$d_{k,t} = \frac{\sum_{i=1}^{n} I_{ik,t}}{V_{k,t}}, \tag{17}$$

where V is the value, I is gross rental income, d is the discount rate, while the subscripts i, k and t denote property, country and time, respectively. Also, note that the value in equation (17) is the reported appraisal value for all properties, whereas the value in equation (16) is the imputed value for a specific property.

The reported appraisal values have been corrected for a change in Rodamco's accounting standards with respect to the valuation of its real estate portfolio. Since 1989, acquisition costs are no longer taken into account, resulting in a timely depreciation of 2.4%. For each year until 1988, the appraisal values have been corrected accordingly, i.e., by subtracting 2.4% of the reported figure. This uniformly lowers the observed levels of returns, but leaves the variances unaltered.

Property-specific total returns have been calculated from imputed values and gross rental-income figures, all stated in local currencies:

$$r_{ik,t} = \frac{V_{ik,t+1} + I_{ik,t}}{V_{ik,t}} - 1, \tag{18}$$

where $r_{ik,t}$ is the total return of property i in country k from time t to $t+1$. These total returns have been adjusted for increases or decreases in square footage per property. Although nearly 20% of the property returns have thus been corrected, the results presented below are essentially the same as if no such correction had been applied.[2] Furthermore, rental-income figures have been adjusted for real estate operating expenses, which are specified per country. These operating expenses differ substantially across countries, but show little variation through time.

It should be noted that many properties have been held in the Rodamco portfolio for less than the full sample period. Therefore, the properties' return variances have been calculated period by period with respect to the (annual) returns on the sample properties' index. Hence, the average property-return variance results from summing the average variance with respect to the index and the variance of the index returns itself. The average number of properties adding to the variance of returns is determined by forming the following ratio:

$$N^c = \sum_{i-1}^{n} \frac{t_i - 1}{T - 1}, \tag{19}$$

where N^c is the average number of properties adding to the variance of returns, t_i is the number of years that property i is included in the sample, T is the full sample period in years (for the U.S. and E.C. properties $T=11$, for the U.K. properties $T=3$).

Appraisal Values

The present study is based upon independent outside appraisals of Rodamco's properties. However, some authors, including Firstenberg, Ross and Zisler (1988), for instance, have criticized the use of appraisal values to infer the riskiness of real estate investments. Empirical analyses of U.S. data have shown that appraisal-based return series are 'smoothed', i.e., display little variation and strong serial correlation. To explain this phenomenon, some authors have argued that appraisers rely heavily on previous appraised values due to 'transaction noise' (Quan and Quigley, 1989, 1991) or 'lack of confidence' (Geltner, 1989). Yet these theories of potential sources of appraisal smoothing have not been supported by empirical evidence.

De Wit (1993) finds empirical support for the contention that in-house appraisals are a potential source of smoothing bias. In contrast, using the same data as the present study, he cannot reject the hypothesis that independent outside appraisals are not smoothed. This suggests that appraisal smoothing depends on whether in-house or outside appraisers are employed. Using independent outside appraisals only, the present study thus avoids at least one potential source of smoothing bias.

Temporal aggregation of 'outdated' appraisals, however, might still affect the observed variation of returns. Geltner (1993) provides a detailed analysis of temporal aggregation, which indeed happens to be a source of appraisal smoothing in the present study. First, De Wit (1993) finds that the October, November and December stock returns are significantly positively correlated with the appraisal-based returns derived from the financial reports of the years ending following February, thus 4, 3 and 2 months later, respectively. Conforming with this observation, Rodamco's 1992/1993 annual report discloses that each year, instead of at the end of February, all properties are valued at the end of December. Given the temporal aggregation of appraisals over the last quarter of the calendar year, Geltner's (1993) analysis suggests that one might expect the ratio of the 'true' to observed variance of returns to be 1.09.

Second, Rodamco's 1992/1993 annual report admits that, until then, the properties on the European Continent had been appraised evenly throughout the year. This far more serious source of appraisal smoothing can be expected to generate a 'true' variance of 1.50 times the observed variance (see Geltner, 1993). Consequently, the variance of the observed E.C. index returns was multiplied by 1.50, while the variances of the observed U.S. and U.K. index returns were both multiplied by 1.09. For the All Properties Index, the weighted average of these factors was determined at 1.26.[3]

Empirical Results

Summary statistics for the return distributions of the Rodamco sample and subsamples are presented in Exhibit 3. The individual property returns were equally weighted, while the portfolios were reallocated at the beginning of each period to maintain equal weights. The mean return of the All Properties Index appears to be 16.9% per annum over the 1979–89 sample period. The mean returns of the subindexes for properties located in the U.S., E.C. and U.K. are 19.4%, 11.7% and 32.0%, respectively. The U.K. subindex, however, only pertains to the period 1987–89 of generally 'booming' real estate prices; this affects the time-series' returns, but not necessarily the cross-sectional variation of property returns, which is the primary focus of the present study.

Measures of the variability of the index returns are also reported in Exhibit 3. As stated before, all returns are measured in local currencies, so that currency risks do not add to the reported risk measures. The sample standard deviations, adjusted for smoothing, appear to vary from 5.6% and 9.1% in the U.S. and E.C., respectively, to 28.5% in the U.K.; the standard deviation of the All Properties Index is 8.8%.

It is interesting to note, for instance, that the U.S. properties exhibit higher returns and less risk than the E.C. properties (that is, in the absence of currency risks). This does not seem to support the case for international diversification. The subsequent analysis, however, is confined to estimating real estate diversification benefits *within* the U.S., E.C. and U.K. using the cross-sections of property-specific data.

Exhibit 3
Summary Statistics for the Rodamco Real Estate Indexes

	U.S.	E.C.	U.K.	All
Mean	19.35%	11.70%	31.99%	16.92%
Median	17.10%	10.06%	43.69%	13.78%
Std Dev.	5.64%	9.06%	28.52%	8.79%
Coeff. of Var.	0.29	0.77	0.89	0.52

Notes: The U.K. Properties Index is based upon three observations in the period 1987–89; the U.S., E.C. and All Properties Indexes contain eleven years of annual data.

Estimates of Diversification Benefits

Exhibit 4 presents the variances of the returns on the subindexes, and the average variances of the property returns. The average correlation coefficient between the property returns is estimated by substituting the empirical values of the aforementioned variables in equation (6). For the U.S. properties, it is found that:

$$\bar{\rho}_{ij} = \left[\frac{3.18}{28.30}\right]\frac{18.1}{17.1} - \frac{1}{17.1} = 0.060\,.$$

This indicates that 94.0% of property-specific return variance can be diversified away when holding an infinite number of U.S. properties.

For portfolios with finite numbers of U.S. properties, Exhibit 5 provides further insight into the diversification benefits. Using equation (4), the variances of portfolio returns were calculated at given numbers of properties. Evans' δ_v confirms that the diversifiable component of the total variance of returns reduces at the rate of $1/n$; by randomly selecting twenty properties, for instance, 95% of diversifiable risk is eliminated.

Also, note that the total variance reduces asymptotically to the average covariance between the property returns, which amounts to 6.0% of total variance. Exhibit 6 illustrates the rate at which the variance of returns is reduced as portfolio size increases, as well as the level of maximum risk reduction.

A different perspective on the diversification benefits of U.S. real estate is provided by the measure of excess variance from imperfect diversification, τ_v, which relates the remaining diversifiable risk to total portfolio risk (see Exhibit 5). Although τ_v declines as portfolio size increases, it is uniformly high; for instance, the variance of returns of a portfolio of twenty randomly selected U.S. properties is 44% diversifiable. This may also be inferred from Exhibit 6, that is by relating the distance between the 'variance-reduction curve' and the 'average-correlation line' to the distance between the former and the horizontal axis.

The excess standard deviation from imperfect diversification, τ_s, is somewhat smaller in percentage terms than τ_v, but displays the same pattern (see Exhibit 5). The required excess return from imperfect diversification is a function of this τ_s, portfolio size, and the return in excess of the risk-free rate of interest. The latter is, following Statman (1987), assumed to be 8.2% for a lending investor and 6.2% for a borrowing investor.[4] Based on

Exhibit 4
Average Correlation Coefficients among U.S., E.C. and U.K. Property Returns

	σ_N^2	$\bar{\sigma}_i^2$	N^c	$\bar{\rho}_{ij}$
United States	3.18	28.30	18.1	0.060
European Continent	8.22	18.88	19.0	0.404
United Kingdom	81.38	387.18	7.5	0.189

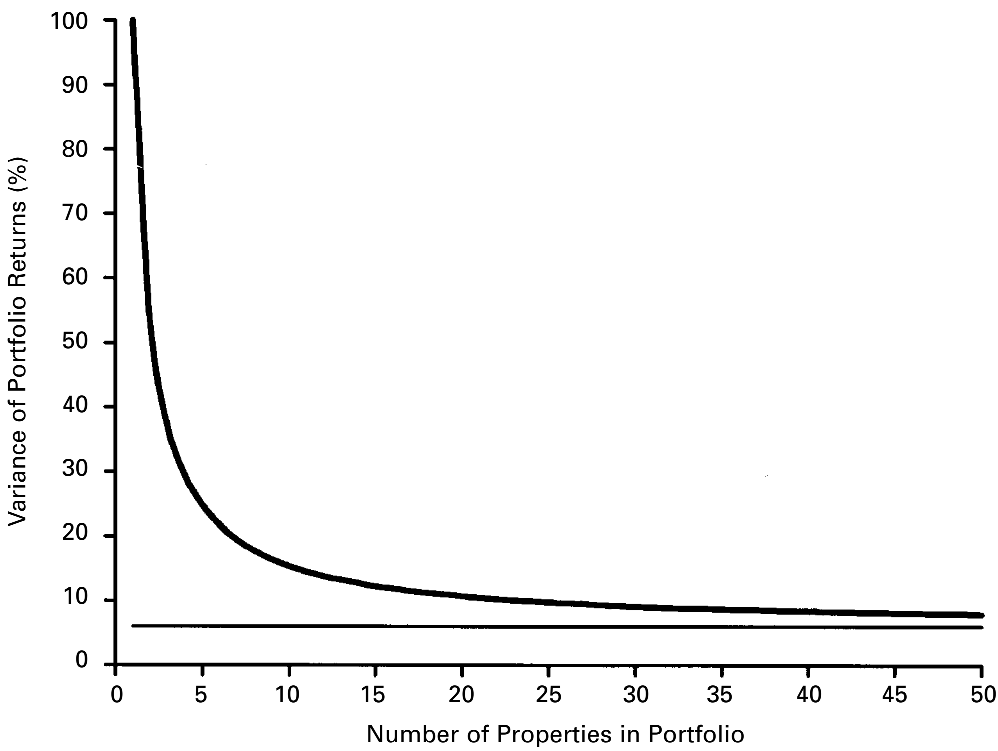
Notes: σ_N^2 is the variance of returns on an equally weighted reallocation index of all properties in subsample (times 1,000), $\bar{\sigma}_i^2$ is the average variance of property returns in subsample (times 1,000), N^c is the average number of sample properties adding to the variance of returns, and $\bar{\rho}_{ij}$ is the average correlation coefficient among property returns.

Exhibit 5
Variances of Returns on U.S. Real Estate Portfolios of Various Numbers of Randomly Selected Properties

	σ_n^2	δ_v (%)	τ_v (%)	τ_s (%)	$\pi_{+8.2\%}$ (%)	$\pi_{+6.2\%}$ (%)
$n=1$	28.30	100.0	94.0	75.5	25.3	19.1
$n=2$	15.01	50.0	88.7	66.4	16.2	12.2
$n=4$	8.36	25.0	79.7	54.9	10.0	7.5
$n=6$	6.14	16.7	72.3	47.4	7.4	5.6
$n=8$	5.03	12.5	66.2	41.9	5.9	4.5
$n=10$	4.37	10.0	61.0	37.6	4.9	3.7
$n=20$	3.04	5.0	43.9	25.1	2.8	2.1
$n=50$	2.24	2.0	23.9	12.7	1.2	0.9
$n=\infty$	1.71	0.0	0.0	0.0	0.0	0.0

Notes: σ_n^2 is the variance of returns on a portfolio of n properties (times 1,000), δ_v is the rate at which the variance of returns is reduced with increasing numbers of properties in a portfolio, τ_v (τ_s) is the excess variance (standard deviation) from imperfect diversification, and $\pi_{\mu-r_f}$ is the required excess return from imperfect diversification, given $\mu-r_f$, the return in excess of the risk-free rate of interest.

Exhibit 6
The Effect of the Number of Properties on the Variances of U.S. Real Estate Portfolios



these assumptions, the required excess return from imperfect diversification, π, is determined for portfolios of increasing numbers of properties. It appears that, for example, a portfolio of twenty U.S. properties would require a 2.8% (2.1%) excess return from imperfect diversification for a lending (borrowing) investor, who would thus require an 11.0% (8.3%) return in excess of the risk-free rate of interest. A further discussion of these findings follows below.

For the E.C. subsample, however, very dissimilar results are obtained. The average correlation coefficient between the E.C. property returns is 0.404 (see Exhibit 4). This indicates that only 59.6% of property-specific return variance can be diversified away. Thus, larger diversification benefits are realized within the U.S. subsample than within the E.C. subsample.

Exhibit 7 provides numerical values of the diversification benefits of portfolios with finite numbers of E.C. properties, while Exhibit 8 illustrates the rate at which risk is reduced, as well as the level of maximum risk reduction. These may be compared with Exhibits 5 and 6, respectively. First, note that the rate at which the variance of returns is reduced, δ_v, is similar for the U.S. and E.C. properties, that is $1/n$. However, the excess variance (standard deviation) from imperfect diversification, τ_v (τ_s), is much larger for U.S. portfolios than for E.C. portfolios of similar size. For instance, the excess variance of U.S. and E.C. portfolios of eight properties is 66% and 16% of total portfolio variance, respectively. Note also that in Exhibit 8 the distance between the variance-reduction curve and the average-correlation line is only a small fraction of the distance between the former and the horizontal axis. This illustrates that the excess variance from imperfectly diversified portfolios of E.C. properties is relatively small.

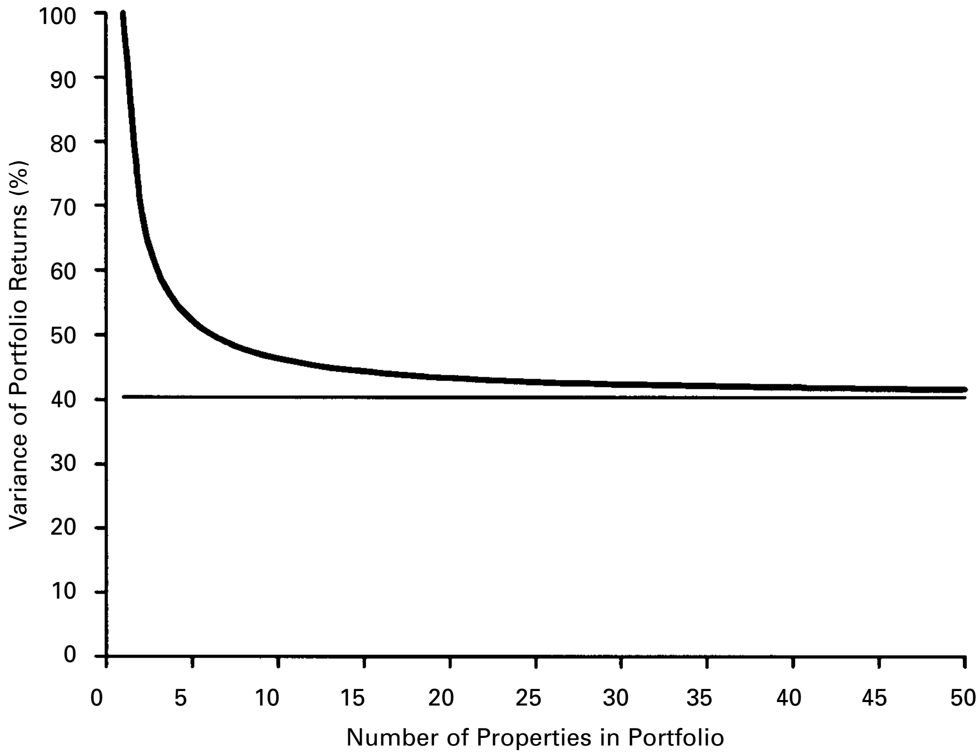
Due to the relatively low τ_s, the required excess return from imperfect diversification is much smaller for E.C. portfolios than for U.S. portfolios of similar size (see Exhibits 5 and 7). For example, a lending investor would require an excess return of 0.3% on a

Exhibit 7
Variances of Returns on E.C. Real Estate Portfolios of Various Numbers of Randomly Selected Properties

	σ_n^2	δ_v (%)	τ_v (%)	τ_s (%)	$\pi_{+8.2\%}$ (%)	$\pi_{+6.2\%}$ (%)
$n=1$	18.88	100.0	59.6	36.4	4.7	3.6
$n=2$	13.25	50.0	42.5	24.1	2.6	2.0
$n=4$	10.44	25.0	26.9	14.5	1.4	1.1
$n=6$	9.51	16.7	19.7	10.4	1.0	0.7
$n=8$	9.04	12.5	15.6	8.1	0.7	0.5
$n=10$	8.76	10.0	12.9	6.6	0.6	0.4
$n=20$	8.19	5.0	6.9	3.5	0.3	0.2
$n=50$	7.86	2.0	2.9	1.4	0.1	0.1
$n=\infty$	7.63	0.0	0.0	0.0	0.0	0.0

Notes: σ_n^2 is the variance of returns on a portfolio of n properties (times 1,000), δ_v is the rate at which the variance of returns is reduced with increasing numbers of properties in a portfolio, τ_v (τ_s) is the excess variance (standard deviation) from imperfect diversification, and $\pi_{\mu-r_f}$ is the required excess return from imperfect diversification, given $\mu-r_f$, the return in excess of the risk-free rate of interest.

Exhibit 8
The Effect of the Number of Properties on the Variances of E.C. Real Estate Portfolios



portfolio of twenty E.C. properties, i.e., 250 basis points less than on a U.S. portfolio of the same number of properties; the difference is 190 basis points for a borrowing investor. These differences arise solely from differences between the average correlation coefficients between U.S. and E.C. returns. The relatively low $\bar{\rho}_{ij}$ for the U.S. market implies that portfolios of small numbers of U.S. properties would require large return premia.

For an explanation of the relatively low level of diversifiable risk of the E.C. properties, one may recall that the E.C. subsample contains few retail properties. This contrasts with the U.S. subsample, which is dominated by retail properties with so-called percentage rents, meaning that the actual rent paid depends partially on (some percent of) realized turnover. Retail rents on the E.C. are usually fixed for three to five years, adjusted only for the rate of inflation. Thus, the absence of retail properties with percentage rents in the E.C. subsample may help to explain the relatively low level of diversifiable risk found within this subsample.

Finally, the average correlation coefficient between the U.K. property returns is estimated at 0.189 (see Exhibit 4). Thus, 81.1% of property-specific returns variance in the U.K. portfolio can be diversified away. The diversification benefits within the U.K. subsample appear to be smaller than within the U.S. subsample, but considerably larger than within the E.C. subsample. Exhibits detailing the diversification benefits of portfolios with increasing numbers of U.K. properties would fall in between the ‘extremes’ of the U.S. and E.C. subsamples and are therefore not shown.

Comparison with Previous Findings

Little evidence on real estate diversification benefits exists to put our findings into perspective. Firstenberg et al. (1988), and Froland, Gorlow and Sampson (1986), for instance, use aggregate data on property groupings.[5] However, due to the indivisibility of property ownership, an investor typically holds an imperfectly diversified portfolio of real estate assets, which contains at least some diversifiable risk. Emperical analyses of real estate diversification benefits should, therefore, use property-specific data. The following studies comply with this criterium.

Dokko, Edelstein, Pomer, and Urdang (1991) compute annual appraisal-based returns for 102 (mostly industrial) properties, which are held in various CREFs, during the period 1976–84. Their Table 2 reports the *real* mean annual rate of return of all properties in each of the nine years, as well as the standard deviations. By backing in the annual CPI figures, the nominal index returns can be retrieved, from which the variance of the index returns through time (σ_N^2) is found to be 4.197. Also, the average variance of the property returns results from summing the average variance with respect to the index and σ_N^2, that is 22.562. Then, using equation (6), $\bar{\rho}_{ij}$ is found to be 0.178.

Grissom, Kuhle and Walther (1987) simulate real estate returns based upon transaction prices, net operating income data and financing terms, for 170 properties in two Texas cities during the period 1975–83. They report that the average variance of a portfolio of ten properties is reduced by 58.3% of the average variance of one property. These proportions may be substituted into equation (6) to yield an estimate of $\bar{\rho}_{ij}$, i.e., ((0.417/1.000) (10/9)−1/9=) 0.352.

Hartzell, Hekman and Miles (1986) use property-specific data from a large open-end CREF. These authors present proportions of non-diversifiable return variation to total return variation for the 220 (mostly industrial) properties that were held continuously in the fund’s portfolio from 1978 until 1983. Note that these ratios differ from estimates of $\bar{\rho}_{ij}$ for a finite number of assets. From the figures presented by the authors’ Tables 11 and 12, it can be inferred that the average correlation coefficient between the properties’ quarterly returns is 0.087, and that the average correlation coefficient between the annual returns is 0.178. The authors refer to ‘the appraisal problem’ as an explanation of the finding that the annual returns indicate smaller diversification benefits than do the quarterly returns; the latter are based upon the fund’s in-house appraisals in three of every four quarters.

Webb, Miles and Guilkey (1992) construct quarterly real estate returns for a sample of 322 unsold properties contained in the Russell-NCREIF Index from the third quarter 1980 through the second quarter 1988. These returns are derived from a valuation model based on transaction prices of a sample of sold properties. Webb et al. present the average standard deviation of the individual property returns, as well as the standard deviation of an equally weighted index thereof (see the authors’ Table 5). From these figures, it can be inferred that the average correlation coefficient between the transactions-driven property returns is 0.014. For appraisal-based returns of the same sample of unsold properties, it appears that the average correlation coefficient is 0.055.

The findings from these studies are summarized in Exhibit 9. The relatively small diversification benefits found in Grissom et al. (1987) is possibly explained by the properties being located in only two cities, whereas the other studies pertain to more regionally diversified samples. In the latter instances, the estimates of the average correlation coefficient among returns range from 0.014 to 0.178. It may thus be concluded that our estimate of 0.060 is at the lower end of the range of estimates from earlier studies of U.S. diversification benefits.

Evidence of non-U.S. real estate diversification benefits is scarce, especially concerning E.C. real estate. For the United Kingdom, Brown (1991, pp. 165–205) uses monthly appraisal values and cash flows of 135 properties during the period 1979–82. This author estimates diversification benefits by fitting the empirical model of Evans and Archer (1968) to the properties' returns data, but this model has been shown above to yield incorrect results. The average correlation coefficient between the returns may nevertheless be estimated from Brown's tables 4.4 and 4.5: the outcome appears to be 0.095, as shown in Exhibit 9, which is about half our estimate of U.K. real estate diversification benefits.

Conclusions

Diversification benefits have been shown to depend on the average correlation coefficient among returns. This measure indicates the level of maximum risk reduction, the rate at

Exhibit 9
Comparison with Previous Findings

	Sample Period	Basis of Valuation	Frequency of Data	N	$\overline{\rho}_{ij}$
United States					
Dokko, Edelstein, Pomer, and Urdang (1991)	1976–1984	appraisals	annual	102	0.178
Grissom, Kuhle and Walther (1987)	1975–1983	transactions	annual	170	0.352
Hartzell, Hekman and Miles (1986)	1978–1983	appraisals	quarterly	220	0.087
Hartzell, Hekman and Miles (1986)	1978–1983	appraisals	annual	220	0.178
Webb, Miles and Guilkey (1992)	1980–1988	transactions	quarterly	322	0.014
Webb, Miles and Guilkey (1992)	1980–1988	appraisals	quarterly	322	0.055
Present paper	1979–1989	appraisals	annual	29	0.060
European Continent					
Present paper	1979–1989	appraisals	annual	33	0.404
United Kingdom					
Brown (1991)	1979–1982	appraisals	monthly	135	0.095
Present paper	1987–1989	appraisals	annual	41	0.189

Note: N is the number of properties included in the sample, and $\overline{\rho}_{ij}$ is the average correlation coefficient among property returns.

which risk is reduced, and the required excess return from imperfect diversification. The latter aspect is particularly important for real estate portfolios because property ownership is often indivisible, so that perfectly diversified portfolios are illusory.

The evidence generated using data of the Rodamco portfolio indicates that as much as 94% of the total risk of U.S. properties can be diversified away. For the U.K. properties, the percent diversifiable risk has been estimated at 81%. The diversifiable risk of the E.C. properties appears to be less than 60% of total risk. Estimates from the previous literature are either higher or lower than our findings regarding U.S. real estate and lower with respect of U.K. real estate; the evidence of E.C. real estate diversification benefits presented here, however, is unprecedented.

Due to the relatively low average correlation coefficient between the U.S. returns, the required excess return from imperfect diversification is much higher for U.S. portfolios than for E.C. portfolios of similar size. Under plausible assumptions, a portfolio of twenty U.S. properties would require an excess return of 210 to 280 basis points, whereas a similar E.C. portfolio would require an excess return of only 20 to 30 basis points. The required excess return from imperfectly diversified portfolios of U.K. properties would be between those of U.S. and E.C. portfolios.

These findings have major implications for the behavior of real estate investors and for the existence of financial intermediaries, such as REITs and CREFs. Because real estate portfolios cannot be perfectly diversified, financial intermediaries may exist as a method for providing lower levels of risk. The preceding analysis suggests that U.S. real estate investors with little information about property-specific returns and covariances would be prepared to incur large costs for sharing risks through REITs and/or CREFs. Alternatively, investors who hold direct property ownership should expect that their in-house real estate expertise adds enough value to offset the estimated opportunity costs. The present study, thus, provides a framework for investors to decide between direct and indirect ownership of real estate investments.

Notes

[1]That is, by assuming $\bar{\sigma}_{ij}=\bar{\rho}_{ij}\bar{\sigma}_i^2$:

$$\frac{\sigma_n^2-\bar{\sigma}_{ij}}{\bar{\sigma}_{ij}}=\frac{\frac{1}{n}+\bar{\rho}_{ij}\frac{n-1}{n}}{\bar{\rho}_{ij}}-1.$$

[2]In two instances, square footage for a particular property more than doubled in a subsequent year. Therefore, the relevant property returns have been excluded from the set of data. The normal procedure has been to correct an unadjusted change in gross rental income of, say, +20% and a concurrent 20% increase in square footage to an adjusted 0% change in income.

[3]The smoothing factors for the subindexes were weighted according to the average number of properties adding to the variance of returns (see equation 19).

[4]These risk premiums were calculated for the largest 500 U.S. stocks over the period 1926–84 (see Statman, 1987). Long-term average returns for U.S. real estate are not available. It was therefore decided to take the stock returns as a proxy for real estate returns.

[5]Also, see Cole, Guilkey, Miles, and Webb (1989), Hartzell, Shulman and Wurtzebach (1987), and Mueller and Ziering (1992).

References

Brown, G. R., *Property Investment and the Capital Markets*, London: E & FN Spon, 1991.

Cole, R., D. Guilkey, M. Miles, and B. Webb, More Scientific Diversification Strategies for Commercial Real Estate, *Real Estate Review*, 1989, 19:1, 59–66.

De Wit, D. P. M., Smoothing Bias in In-House Appraisal-Based Returns of Open-End Real Estate Funds, *Journal of Real Estate Research*, 1993, 8:2, 157–70.

Dokko, Y., R. H. Edelstein, M. Pomer, and E. S. Urdang, Determinants of the Rate of Return for Nonresidential Real Estate: Inflation Expectations and Market Adjustment Lags, *Journal of the American Real Estate and Urban Economics Association*, 1991, 19:1, 52–69.

Elton, E. J. and M. J. Gruber, Risk Reduction and Portfolio Size: An Analytical Solution, *Journal of Business,* 1977, 50:4, 415–37.

———, *Modern Portfolio Theory and Investment Analysis*, New York: John Wiley, fourth edition 1991.

Evans, J. L. and S. H. Archer, Diversification and the Reduction of Dispersion: An Empirical Analysis, *Journal of Finance*, 1968, 23:5, 761–67.

Evans, J. L., An Examination of the Principle of Diversification, *Journal of Business Finance and Accounting*, 1975, 2:2, 243–55.

Firstenberg, P. M., S. A. Ross and R. C. Zisler, Real Estate: The Whole Story, *Journal of Portfolio Management*, 1988, 14:3, 22–34.

Froland, C., R. Gorlow and R. Sampson, The Market Risk of Real Estate, *Journal of Portfolio Management*, 1986, 12:3, 12–19.

Geltner, D., Estimating Real Estate's Systematic Risk from Aggregate-Level Appraisal-Based Data, *AREUEA Journal*, 1989, 17:4, 463–81.

———, Temporal Aggregation in Real Estate Return Indices, *Journal of the American Real Estate and Urban Economics Association*, 1993, 21:2, 141–66.

Grissom, T. V., J. L. Kuhle and C. H. Walther, Diversification Works in Real Estate, Too, *Journal of Portfolio Management*, 1987, 13:2, 66–71.

Hartzell, D., J. Hekman and M. Miles, Diversification Categories in Investment Real Estate, *AREUEA Journal*, 1986, 14:2, 230–54.

Hartzell, D. J., D. G. Shulman and C. H. Wurtzebach, Refining the Analysis of Regional Diversification for Income-Producing Real Estate, *Journal of Real Estate Research*, 1987, 2:2, 85–95.

Latané, H. A. and W. H. Young, Test of Portfolio Building Rules, *Journal of Finance*, 1969, 24:4, 595–612.

Mao, J. C. T., Essentials of Portfolio Diversification Strategy, *Journal of Finance*, 1970, 25:5, 1109–21.

Mueller, G. R. and B. A. Ziering, Real Estate Portfolio Diversification Using Economic Diversification, *Journal of Real Estate Research*, 1992, 7:4, 375–86.

Quan, D. C. and J. M. Quigley, Inferring an Investment Return Series for Real Estate from Observations on Sales, *AREUEA Journal*, 1989, 17:2, 218–30.

———, Price Formation and the Appraisal Function in Real Estate Markets, *Journal of Real Estate Finance and Economics*, 1991, 4:2, 127–46.

Samuelson, P. A., General Proof that Diversification Pays, *Journal of Financial and Quantitative Analysis*, 1967, 2:1, 1–13.

Statman, M., How Many Stocks Make a Diversified Portfolio? *Journal of Financial and Quantitative Analysis*, 1987, 22:3, 353–63.

Webb, R. B., M. Miles and D. Guilkey, Transactions-Driven Commercial Real Estate Returns: The Panacea to Asset Allocation Models? *Journal of the American Real Estate and Urban Economics Association*, 1992, 20:2, 325–57.

Whitmore, G. A., Diversification and the Reduction of Dispersion: A Note, *Journal of Financial and Quantitative Analysis*, 1970, 5:2, 263–64.

This study is based on part of my doctoral dissertation, which I completed at the Tinbergen Institute/University of Amsterdam in 1993. I wish to thank L. A. Ankum, Graeme Newell, Kerry D. Vandell, and participants at the 1993 Annual Meeting of the American Real Estate Society for helpful comments on earlier drafts. The study was previously entitled "Additional Diversification Benefits from Alternative Real-Estate Portfolio Investment Strategies".